CLAIMS

WE/I CLAIM:

1. In an automatic utility meter reading system that transmits utility data signals, an adjustable bandwidth receiving apparatus, comprising:

a memory module for storing data, instructions, or both;

a receiver for receiving utility meter data signals:

a processor coupled with the memory module and the receiver, wherein the receiver and the processor are configured to:

match a receiver local oscillator (LO) frequency to a carrier (SC) frequency of the receiver signals to compensate for a frequency difference, wherein the matching comprises:

receiving a first signal representing a first binary value at a first data rate;

mixing the first signal with a signal generated by the LO, wherein the LO frequency is an expected SC frequency;

filtering the first mixed signal;

receiving a second signal representing a second binary value at the first data rate;

mixing the second signal with the signal generated by the LO;

filtering the second mixed signal;

computing an average value of the two filtered signals, wherein the computed average value is a difference between the SC and the LO frequencies;

adjusting the LO frequency by the computed average value;

adjusting the bandwidth based on the computed average value to allow a signal with an estimated maximum frequency error to pass; and

receiving subsequent data signals at a second data rate that is higher than the first data rate; and

wherein data signals are frequency modulated (FM), and wherein the first binary value is transmitted by a frequency that is a sum of a deviation frequency and the SC frequency and the second binary value is transmitted by a frequency that is a difference of the SC frequency and the deviation frequency.

2. The apparatus of claim 1, wherein the processor provides a compensation signal to match the LO frequency to the SC frequency based on the computed value, and adjusts the bandwidth around the matched LO frequency, based on the computed value.

3. The apparatus of claim 1, wherein one of the two filtered signals is a baseband in-phase signal and the other filtered signal is a baseband quadrature signal.

4. In a wireless utility meter reading system of data receivers and transmitters, a method of adjusting a receiver, wherein transmitters transmit frequency modulated (FM) binary data, and wherein a first binary value is transmitted by adding a deviation frequency to a local oscillator (LO) frequency of the transmitter and a second binary value is transmitted by subtracting the deviation frequency from the transmitter's LO frequency, the method comprising:

receiving a signal representing the first binary value;

down-converting the received signal with a signal generated by a LO of the receiver, wherein a frequency of the receiver's LO is substantially similar to an estimation of the transmitter's LO frequency;

filtering the down-converted signal;

computing a difference between the transmitter's LO frequency and the receiver's LO frequency by subtracting the deviation frequency from the filtered signal, if the received signal represented the first

binary value, or by adding the deviation frequency to the filtered signal, if the received signal represented the second binary value;

compensating the receiver's LO frequency by the computed difference if the receiver's LO frequency needs to be altered; and

adjusting a bandwidth of the receiver filter to allow an estimated maximum frequency error to pass, if the receiver's bandwidth needs to be adjusted.

5. The method of claim 4, wherein a compensation signal associated with the computed difference adjusts the bandwidth of a variable filter based on an estimated worst case frequency error.

6. The method of claim 4, wherein the bandwidth of the receiver is narrowed around the adjusted frequency based on the computed difference.

7. In a wireless communication network, a method comprising:

receiving a first signal representing a first coded value, wherein the first signal is transmitted at a transmitter carrier frequency, and wherein a transmitted signal includes coded values related to the transmitter carrier frequency;

mixing the first signal with a receiver carrier frequency, wherein the receiver carrier frequency is associated with the transmitter carrier frequency;

receiving a second signal representing a second coded value;

mixing the second signal with the receiver carrier frequency; and

computing a difference between the transmitter carrier frequency and the receiver's carrier frequency based on the two mixed signals.

8. The method of claim 7, wherein the coded values are binary, and wherein the method further comprises centering the receiver carrier frequency to match the transmitter carrier frequency, and adjusting a bandwidth of a receiver variable filter around the centered receiver carrier frequency.

9. The method of claim 7, wherein one of the first and second mixed signals is a baseband in-phase signal and the other first and second mixed signal is a baseband quadrature signal.

10. In a communication system, an apparatus for compensating for drift between a receiver and a transmitter local oscillator frequencies, the apparatus comprising:

a receiver for receiving a first frequency modulated signal with frequency (F_T+f_1) representing a first data value, and a second frequency modulated signal with frequency (F_T-f_2) representing a second data value, where F_T is a local oscillator frequency of the transmitter, and f_1 and f_2 are frequency deviations for modulating the first and the second data values, respectively;

a mixer for down-converting or intermediate frequency (IF) converting the first and the second received signals by mixing the first and second received signals with the receiver's local oscillator frequency, wherein the receiver's local oscillator frequency is associated with conversion frequency; and

calculating a drift between the transmitter's local oscillator frequency and the receiver's local oscillator frequency, F_D, by:

$F_D = F_{M2} + f_2(F_{M1} - F_{M2})/(f_1+f_2)$,

where F_{M1} and F_{M2} are first and second down- or IF-converted frequencies, respectively.

11. The apparatus of claim 10, wherein during an initial communication period, the receiver widens a receiver bandwidth and receives data at a first data rate, and wherein during a subsequent period the receiver adjusts the bandwidth, based on the received data, and receives subsequent data at a second data rate that is higher than the first data rate.

12. The apparatus of claim 10, wherein the first and second data values are "1" and "0," respectively, and wherein at least one controller provides a

compensation signal and adjusts a bandwidth of the receiver based on an estimated frequency drift and compensated receiver frequency.

13. The apparatus of claim 10, wherein one of the down-converted signals is a baseband in-phase signal and the other down-converted signal is a baseband quadrature signal.

14. In a wireless communication system, a method of adjusting receiver bandwidth using a difference between a transmitter local oscillator (LO) frequency and its corresponding receiver LO frequency, the method comprising:

a means for matching the receiver's LO frequency to the transmitter's LO frequency to compensate for frequency shifting, the matching comprising:

a means for receiving at least one signal representing one binary value that is frequency modulated (FM);

a means for down-converting the at least one signal by a signal imitating the frequency of the transmitter's LO;

a means for filtering the down-converted signal;

a means for computing a difference between the transmitter's LO frequency and the receiver's LO frequency based on the filtered signal; and

a means for matching the receiver's LO frequency to the transmitter's LO frequency, using the computed difference; and

a means for adjusting the bandwidth of the receiver based on the computed difference, if the bandwidth needs to be adjusted.

15. In a wireless data acquisition network, a system for narrowing a receiver bandwidth for receiving higher rate data signals, the system comprising:

a receiver for receiving a known frequency modulated (FM) data signal at a first data rate, with frequency (F_T+f) or (F_T-f), wherein F_T is a corresponding transmitter's LO frequency and f is a frequency deviation for modulating the data value;

a mixer for down-converting the signal by mixing it with a signal generated by the receiver LO, wherein the receiver LO frequency is an estimate of the transmitter's LO frequency;

a processor for computing a difference between the transmitter's LO frequency and the receiver's LO frequency by subtracting the deviation frequency f from the down-converted signal if the received signal represents the data value with frequency (F_T+f), or by adding the deviation frequency f to the down-converted signal if the received signal represents the data value with frequency (F_T-f); and

a controller for centering and narrowing the receiver bandwidth, using the down-converted signal, to allow higher data rate signals with maximum estimated drift to pass, if the bandwidth needs to be adjusted.

16. In an automatic utility meter reading system that transmits utility data signals, a process of transmitting data via a transmitter, the process comprising:

transmitting an initial signal representing a first binary value at a first data rate, wherein the initial signal is configured for adjusting a difference between a carrier frequency of the transmitter and a carrier frequency of a utility data collection receiver; and

transmitting the utility data signals at a second data rate that is higher than the first data rate after transmission of the initial signal.

17. In a utility meter data transmission system, a variable bandwidth receiver comprising:

a receiver module for receiving at least two binary data signals or at least one known data signal, wherein data values are frequency modulated by adding to and subtracting from a transmitter carrier frequency in case of the at least two binary data signals and are frequency modulated by adding to or subtracting from a

transmitter carrier frequency in case of the at least one known data signal;

a variable filter for filtering received signals;

a mixer for down- or IF-converting the received signals;

a processor for computing a difference between the transmitter carrier frequency and the receiver carrier frequency based on the down- or IF-converted signals; and

a controller for generating compensation signal for adjusting the filter bandwidth based on the computed difference.

18. The variable bandwidth receiver of claim 17, wherein adjusting the bandwidth comprises:

centering the bandwidth around a frequency substantially similar to the transmitter's frequency;

narrowing the bandwidth; and

transmitting subsequent data at a higher rate than a previous data rate.

19. The variable bandwidth receiver of claim 17, wherein a transmitter transmits the at least one or two signals at a first data rate, during an initial adjustment period, and subsequently transmits data at a higher data rate than the first data rate, during a normal data transfer period, and wherein the receiver widens the receiver filter bandwidth during the initial adjustment period and narrows the bandwidth during the normal data transfer period.

20. A utility meter data communication method comprising:

transmitting binary data signals at a first data rate, by a first utility meter data transceiver;

receiving at least one binary data signal, by a second utility meter data transceiver;

zero-IF or IF converting the received signal;

computing a value that is a difference between the first transceiver carrier frequency and the second transceiver carrier frequency, using the converted signal; and

transmitting the computed information from the second transceiver to the first transceiver to be used for adjusting the first transceiver's carrier frequency, if adjustment is needed.

21. The method of claim 20, wherein the second utility meter data transceiver alters a bandwidth of the second transceiver, based on the computed difference value, if the bandwidth needs to be altered.

22. The method of claim 21, wherein bandwidth alteration comprises:

centering the bandwidth around a frequency substantially similar to the first transceiver's frequency;

narrowing the bandwidth; and

transmitting subsequent data at a second data rate that is higher than the first data rate.

23. In an automatic utility meter reading system that transmits utility data signals, a method of data communication comprising:

at a utility data collection device widening a receiver bandwidth to receive initial communication data at a first data rate;

at the utility data collection device adjusting system parameters based on the received data;

at the utility data collection device narrowing the receiver bandwidth to receive subsequently transmitted data at a second data rate that is higher than the first data rate.

24. In a communication system, an apparatus for compensating for drift between receiver and transmitter local oscillator frequencies, the apparatus comprising:

a receiver for receiving a first frequency modulated signal with frequency (F_T+f_1) representing a first data value, and a second frequency modulated signal with frequency (F_T-f_2) representing a second data value, where F_T is a local oscillator frequency of the

transmitter, and f_1 and f_2 are frequency deviations for modulating the first and the second data values, respectively;

a mixer for mixing the first frequency modulated signal with frequency (F_R+f_1) to generate a first mixed signal and mixing the second frequency modulated signal with frequency (F_R-f_1) to generate a second mixed signal, where F_R is a local oscillator frequency of the receiver, and wherein the receiver local oscillator frequency is an estimation of the local oscillator frequency of the transmitter; and

calculating a drift between the transmitter local oscillator frequency and the receiver local oscillator frequency by averaging between the frequencies of the first and the second mixed signals.